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ABSTRACT

This evaluative report describes a demonstration project undertaken by the Center for Research on Equitable Access to Technology in Education (CREATE) at the Far West Laboratory for Educational Research and Development; the project involved the design and implementation of computer literacy training of minority high school students in San Francisco using peer training. Three phases of the project are discussed: (1) an initial class in BASIC for 12 high school students of varied ethnic backgrounds; (2) a class in which 10 Central American Hispanic students were trained and another in which 11 Samoan students were trained; and (3) implementation of tutoring at a San Francisco high school. An examination of issues related to equitable access to computers in education looks at the extent and type of existing inequities, sex and language inequities, and the effectiveness of computer education for disadvantaged students. Data sources, equipment, procedures, and results of the study are described. Preliminary specifications are offered for a model of peer training in computer literacy, including instructional effectiveness for target students, implementation, school staff involvement and commitment, trainer qualifications, recruiting trainees, scheduling, course length, language problems, and cooperative learning structures. Fifty-one references and six tables are included. (LMM)

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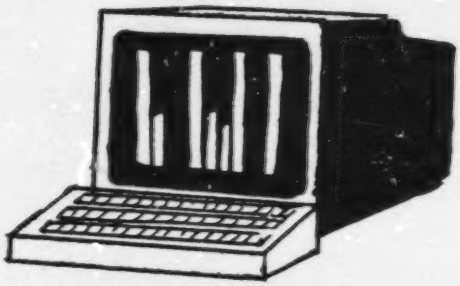

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ACHIEVING EQUITY: STUDENT-LED COMPUTER TRAINING

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I. INTRODUCTION

This paper focuses on exploratory efforts to assess the utility of student-led training in programming to provide access to computer education by disadvantaged students. The objective of the paper is to report on the evaluation of a demonstration project undertaken by the Center for Research on Equitable Access to Technology in Education (CREATE) at the Far West Laboratory for Educational Research and Development. Classes have been conducted thus far for Pacific Islanders, Hispanics, and other minorities. The Center is attempting to generate a model of a computer literacy training program which can be implemented in schools, which addresses the shortage of teachers qualified to teach in this area, and capitalizes on peer tutoring and cooperative learning to enhance cognitive and socio-emotional development of disadvantaged students.

A. Perspectives

The issue of equitable access to computers in education is critical to the educational community and has far-reaching implications for the nation as a whole in preparing the future workforce.

Some estimates say that by 1990 about 8 out of 10 jobs will require some knowledge of computers either directly or tangentially (Frank, 1983; Fisher & Finkel, 1983). However, Stanford researchers Levin and Rumberger argue that even though high-tech jobs will double by 1990, such jobs will still be far outpaced by such low-skill jobs as janitors, nurses' aides, sales clerks, cashiers, waiters and waitresses, and fast-food workers (Siegel, 1983). Even so, they state that with the existing and continuing spread of computers at work and in homes, students do need to learn about computers to help them deal with an increasingly technologically-oriented society, and schools are the "democratizing" institutions that can provide an exposure to children without computer opportunities at home.

Even though all jobs are not going to require sophisticated computer expertise, we must ask ourselves which of today's children will be able to assume those jobs which do require such a background. It has been said that you don't need to be computer literate to work at McDonald's--but the irony of that is the realization that those who do not have "computer literacy" are going to end up as the fast-food workers of the country and won't have an opportunity for the higher-level jobs which consequently will be reserved for those who do have high-tech preparation.

In fact, numerous writers have warned of the dangers of widening the already-existing technology gap between the haves and have-nots if current trends continue (Podemski, et al., 1983; NSBA, 1983; Karoff, 1984; Emmett, 1983; Hechinger, 1983; Puetz, 1984; TERC, 1983; Mace, 1983). The current trend shows that such a gap is indeed apparently widening when statistics for 1979 and 1982 are compared (Anderson et al., 1984). In the next generation the majority of the workforce will be women and minorities (Karoff, 1984), and for the welfare of the nation, it has been argued that they must be included among the technologically-trained workers. Not including the currently underutilizing groups of students (e.g., disdavantaged, minorities, and females) in training for computer literacy might relegate them to the "permanent underclass" of the future (Karoff, 1984; Castillo, 1984; Euchner, 1983).

The Extent (Quantity) of Inequities

Several recent studies confirm the extent of inequities in the amount of computer opportunities or access to school microcomputers. A Market Data Retrieval Study showed that in October 1982 almost 2-1/2 times as many of the country's wealthiest districts had microcomputers compared to the poorest districts (Podemski et al., 1983). The National Assessment of Educational Progress

Study at the University of Minnesota presented data showing that 70% of the wealthiest schools, compared to only 40% of the poorest schools, have micros and that, when comparing the 12,000 wealthiest with the 12,000 poorest districts in the country, the affluent students are four times as likely to have computer access (Karoff, 1984; Anderson et al., 1984).

The National School Boards Assocation in its ComputerWise newsletter summarized the available evidence by saying that two-thirds to three-fourths of the most affluent schools have at least one microcomputer, whereas about 60% of the poorest schools do not have any (NSBA, 1983).

The widely publicized Johns Hopkins study of microcomputer use in schools showed that as elementary schools acquire more computers, they do provide access to a greater number of their students. However, as secondary schools gain more computers, they provide more access time to about the same number of students as before (Becker, 1983 a, b).

The Johns Hopkins survey confirmed that low-income (elementary) schools have higher student-to-computer ratios than high-income schools. One-quarter of high-SES-school students use a computer per week, as opposed to only half that percentage of students in low-income schools. Furthermore, among those low-income schools, the predominantly minority schools had higher student-to-computer ratios than white majority schools, indicating that racial minority students have an added disadvantage over and above their inequitable computer access due to low economic status (Education Daily, 10/31/83).

A 1982 NEA survey of teachers found that a far higher percentage of teachers in suburban areas (41%) and small towns (28%) used computers in instruction than teachers in rural (16%) or urban areas (15%). Reporting of teachers' attitudes showed that 41% of the 1200 teachers responding (34% of non-computer-using teachers, and even 12% of teacher users!) indicated they did not believe there should

be a school policy calling for opportunity for all students to learn to use computers in the classroom (Norman, 1983).

There is additional evidence of computer inequities for disadvantaged and minority students beyond the schools. A survey of 23 summer computer camps in 1982 by Hess and Miura (1983) found that 98% of students enrolled in these camps were from upper-and middle-class families, with only 2% from minority groups (mostly Asians).

The Type (Quality) of Inequities

Study after study likewise has shown the existence of serious disparities in the type of computer use as well as the amount of use by students differing in social class and ability. These studies report that more affluent and higher-achieving students learn programming and advanced computer applications while disadvantaged and low-achieving students (when they do have access) use computers mainly for drill and practice, often for remedial instruction (Arias, 1984; Becker, 1983 a, b; Brookover & Lezotte, 1981; Cardenas, 1983; NSBA, 1983; Karoff, 1984).

As Karoff states,

> "most disturbing are recent data which show that even where access is available to underprivileged students, the quality and sophistication of computer-assisted instruction is frequently found lacking. Poor kids do passive drill and practice exercises... Rich kids learn how to program" (p. 52).

Or, as Watt so aptly puts it, "...affluent students are thus learning to tell the computer what to do, while the less affluent students are learning to do what the computer tells them" (quoted by Cardenas, 1983, p. 3).

Teacher attitudes as well as local and federal resources play a role in fostering such a disparity in quality of computer opportunities. Many teachers feel that learning of computer skills should be targeted at high-achieving, gifted students, while others feel that low-achieving students should concentrate on

building their basic skills through drill and practice uses (Podemski et al., 1983). An additional contributor to this disparity is the requirement for schools purchasing computer equipment with certain federal funds to use them for basic skills with their disadvantaged students (Castillo, 1984).

In a recent NEA survey, 66% of the teachers responding had some (30%) or considerable (36%) interest in the use of computers for enrichment with high ability students; 53% had some (26%) or considerable (27%) interest in computer use for remedial drill and practice for low ability students (Norman, 1983). Apparently this dichotomy in perceived appropriate computer uses is relatively firmly established among the majority of teachers in this country.

Sex and Language Inequities

The pattern of inequities in both quantity and quality of computer access discussed above has also been documented for females and for students who are limited in English language proficiency, as well as minority and disadvantaged students (Hess & Miura, 1983; Arias, 1984; Cardenas, 1983; Campbell, 1983). Considerable attention has focused particularly on the question of sex equity in computer opportunities, but many of the factors affecting such inequity generally apply to limited English proficient (LEP) students as well, especially Hispanics (cf. Arias, 1984; Cardenas, 1983). Other LES or ESL minority groups including those from the Pacific Islands (such as Samoans--who comprised one of our classes) are also subject to the compounded inequities due to both minority ethnic and language status.

Males are more aggressive than females in seeking computer opportunities (Marrapodi, 1983; Campbell, 1983; Hamilton, 1984; Kiesler et al., 1983) and are more likely to learn programming (especially at the level of more advanced programming languages) while females are more likely to learn to use computers for such purposes as word processing (Fisher, 1984; Van Nuys, 1983). Some experience

has shown that computer programming instruction using LOGO or oriented toward art has been more successful in attracting females (Fisher, 1984).

Parents are more likely to support and encourage their sons' than their daughters' pursual of computer interests, whether it be purchasing computers for them (Van Nuys, 1983; The Stanford Educator, 1984; Castillo, 1984; Fisher, 1984) or sending them to computer camps (Hess & Miura, 1983). Software for both games and education (not to mention video arcade games which engender computer interest among many males, especially) are heavily male-oriented (The Stanford Educator, 1984; Kiesler et al., 1983; Marrapodi, 1983; Van Nuys, 1983; Education Daily 1/23/84). More male than female computerist role models abound in the media as well as in schools (Marrapodi, 1983; Van Nuys, 1983).

The emphasis on mathematics in programming courses, as well as the widespread inclusion of computer courses in mathematics (or science) departments and the requirement of certain math courses such as algebra as prequisites to programming courses all serve to restrict the participation of females and many minority students in higher level computer classes such as programming (Kiesler et. al., 1983; Van Nuys, 1983; Arias, 1984; Fisher, 1984).

Because of all these factors, as well as peer culture itself (Van Nuys, 1983; Kiesler et al., 1983), serious computer-using students tend to be overwhelmingly white, male, and from high-SES families.

Effectiveness of Computer Instruction for Underutilizing Students

There is growing evidence that computer-based instruction can be academically beneficial to precisely the types of students who suffer the most from unequal access (e.g., Saracho, 1982). In a meta-analysis of 51 separate studies of the effects of computer-based teaching in grades 6-12, Kulik, Banger, & Williams (1983) found that instruction via computer raised performance of students in general as well as decreased the amount of learning time. Of particular note

to the present discussion was the finding that computer-based learning seemed especially effective for disadvantaged students. In those studies which assessed effects on student attitudes, positive effects of CBI were found as well for attitudes toward subject matter, computers, and instruction.

Even greater achievement effects than reported by Kulik et al. (1983) were shown in ETS research in Los Angeles for younger elementary children (Bracey, 1982; Connell, 1983). Effectiveness of CAI or CBI on student performance and/or attitudes (including enhanced feelings toward self and sense of personal control) has been documented in other studies reported by Ryba & Chapman (1983).

In an overview of CAI research, Bracey (1982) reports that in "the area of affective/motivational outcomes of CAI, the news is almost all good" (p. 54). Teachers have reported that some of the major benefits of computer instruction are improved motivation and attitudes (Becker, 1983; EL News, 1983; Norman, 1983).

Researchers and teachers have also indicated the success of microcomputers in enhancing collaboration and cooperative learning among students (Becker, 1983; Resnick, 1984; Ryba & Chapman, 1983). Bracey (1982) even reports seeing "more collaborative, cooperative problem solving among kids who are doing programming activities together than anywhere else in schools" (p.54).

Other research has documented that various forms of cooperative learning and peer tutoring have been effective in enhancing academic performance among black and Hispanic students and for reducing social distance, improving interracial and school-related attitudes, and fostering equal status interactions among students of different racial and ethnic minorities (e.g., Slavin, 1978; 1980; Aronson et al, 1978; Crist-Whitzel, 1980).

B. A Beginning Effort--A Demonstration Project of Computer Literacy Peer Training

The Center for Research on Equitable Access to Technology in Education (CREATE) was established at the Far West Laboratory for Educational Research

and Development to address these equity issues (see Dasho & Beckum, 1983). The Center's goal is to develop and update the knowledge base regarding equity issues in the use of advanced technology in education.

The beginning thrust of CREATE has been the design and implementation of computer literacy training of minority high school students using peer training. Currently there is a widespread recognition that many adults experience more anxiety than students toward learning to use the computer. Although many teachers enthusiastically embrace the task of learning programming skills, it is widely recognized that students are quickly outpacing teachers and other adults in mastering computer skills (Assembly Office of Research, 1982; Frank, 1983; Time, May 3, 1982). The critical national shortage of science and mathematics teachers (Mace, 1983) compounds the problem of providing the computer literacy instruction to all students which has become a nationally proclaimed goal (National Commission on Excellence in Education, 1983; Lesgold & Reif, 1983; Gibbons, 1983).

One solution to this double problem of lack of available trained teachers and less opportunity for computer training in disadvantaged schools is to have computer-literate pupils teach computer literacy, including computer programming to other students.

Advantages to such peer computer instruction include: (1) peer tutoring and other cooperative learning methods are effective learning modes in general for both tutors and tutees (Cohen et al, 1982; Good & Brophy, 1973), effective particularly for black and Hispanic students, and foster social integration among students of different races/ethnicities (Slavin, 1978; 1980; Aronson et al, 1978); (2) students are proving to be rapid and adaptable computer learners; (3) student trainers gain important skills of designing instruction, training others, and evaluating the implementation process; (4) trainees gain basic computer literacy

and help researchers and trainers identify a training design with high potential for utilization and effectiveness for underutilizers; (5) the expertise of experienced student trainers can become a resource for transferring the teaching model to other groups of students. Also, the peer instructional model requires minimal staff to guide and monitor training; once implemented in a school, can be self-regenerating and cost-effective; and would not require extensive teacher training efforts.

The Center built upon a peer teaching program at San Francisco's Lowell High School and hired six Lowell computer-literate students to develop a peer teaching demonstration project to reach disadvantaged students with little access to computers. A slightly different but effective tutoring model is the Computer Tutor Program based in Palo Alto (Stevens, 1982). The Lowell and Computer Tutor programs have generally targeted higher achieving and gifted students, but the general model seemed to hold promise for academically and/or culturally disadvantaged students with less access to computer instruction because of the research on both cooperative learning and effects of computer-based instruction.

The demonstration project's student trainers and student trainees have been from various ethnic (Hispanic, Pacific Island, Asian, black and white) and socio-economic backgrounds. During the first phase of the training (Spring 1983) 5 of the trainers trained one class enrolling 12 high school students in BASIC. The program was revised for the second training phase in Summer 1983: one class included 10 Hispanic students from Central America, and a second class enrolled 11 Samoan students. The same core of students served as trainers, assisted by tutors who completed the first training session and an additional computer-literate Spanish-speaking student. Arrangements were made with the school district to offer course credit.

A third training phase--implementation of tutoring at a local high school--has begun. CREATE's goal is to develop an exemplary program that can be a model for implementation elsewhere for use with disadvantaged, minority, and female students and thus increase opportunities for these groups' equitable access to computer education. This paper will report evaluation findings and some preliminary model specifications.

II. METHOD

A. Data Sources

Student performance measures. Total (accumulative) school GPA was used as a measure of prior school performance. Data were also gathered for each student's GPA the most recently completed semester before taking the computer class; since this GPA correlated .95 (rho) with total GPA, the latter was used. Performance in the computer class was determined by averaging trainers' ratings of students at the completion of the class. Each trainer rated each trainee on a scale of 1 to 10 on general understanding of programming concepts, ability to use those concepts on his/her own, and the final program. Total performance scores were derived by averaging all scores given to an individual.

Student attitude measure. Students completed daily evaluation forms(FOCUS). They rated on a 5-point scale with 5 being the most favorable score, their Feelings (how interesting) about the day's session, the Organization, Clarity, and their own Understanding of each lesson. They also rated the Speed ("too fast" to "just right" to "too slow") with 3 representing "just right," below 3 "too fast," and above 3 "too slow." A total class rating for each student was derived by averaging the F, O, C, and U scores over all lessons. The S (speed) score with its different scoring system was not included in the total.

Class participation measures. Attendance was used as an indicator of actual participation in training. Although attendance is not a measure of engagement time, it does provide a measure of opportunity to learn. Attendance was quantified as the proportion of days attended to the total instruction days. A proportion was used in order to equate the measure over all three classes, since they differed in total days (21 in Class I, 24 in Class II, and 18 in Class III) although total hours were roughly equivalent (42, 48, and 45 respectively).

Informal staff observations of student initiating and responding interactions with tutors and in whole-group instruction served as a general measure of class interactions.

Other measures. Students also completed both a pretest and posttest structured questionnaire with open-ended responses concerning information such as prior computer experience and knowledge, feelings about computers, self-perceptions about school ability and attitudes toward school, college and career aspiration, and family background. A final structured interview was held with each student to tap such information as: attitudes toward the training class and student trainers, what they liked and disliked about the class, whether they were more or less interested in computers after taking the class, and whether they would try to take another computer class at school.

B. Equipment

The three computer classes which are the subject of the present evaluation report were conducted in the Far West Laboratory's Technology Learning Center using six Commodore VIC-20 computers with cassette recorders and color TV monitors. Classes were limited to 12 trainees each with two students per computer.

C. Procedures

1. Course Preparation

Subsequent to contacts with Lowell High School, an academically-oriented public high school in San Francisco, an ethnically mixed group of six computer-literate 9th - to 11th-grade students was selected to be trainers. Two were females (one Hispanic, one White) and four were males (one Asian, one Black, two White). Several of these students had already participated in developing and teaching a BASIC programming course at Lowell.

With assistance of CREATE staff, the student trainers in January and February 1983 identified course topics with projected time allotments, developed the curriculum, prepared lesson plans, and arranged a 42-hour-long BASIC programming course schedule to be used with CREATE's target students.

2. Pilot Class (Class I)

CREATE staff, through coordination with a nearby inner-city high school, then selected a group of 12 trainees from a pool of 19 students who had signed up at the school. The students, ranging from 9th- through 11th-graders, were divided evenly between males and females, and, as much as possible, represented an ethnic mix as well as little or no prior experience with computers (especially in programming), and average to below-average students (as judged by self-reports of liking for and ability in reading and math.

Description of Students. Twelve students (six males, six females) initially enrolled. Ethnicity included one Black, one White, five Hispanics, and five Asians (three Chinese, one Vietnamese, one Filipina). Five had never had contact with computers; several had used them only in reading or writing labs at the high school (for drill and practice); and one had used a computer to record attendance data when she served as an office assistant at her middle school.

Three male students (Hispanic, Vietnamese, Chinese) dropped out during the first three weeks, reportedly because of conflicts with jobs or school activities. The remaining nine students (three males, six females) completed the entire instructional phase of the course, although two Hispanic females dropped out at the end of the fifth week, after they had begun to write their own programs. Although our attempts to reach them by phone or mail failed, we speculate that a combination of language problems, insecurity, and/or inability to go through the process of writing programs on their own led to their dropping out.

The seven who completed the entire course included two Hispanic females, one Black female, one Filipina, two Chinese males, and one White male. Thus, the 75% retention rate of the first five weeks dropped to 58% by the end of the class.

Instruction and Class Schedule. Class I was conducted for seven weeks duduring March, April, and May, 1983--two hours per day each Tuesday, Wednesday, and Thursday after school hours. During sessions over the first four weeks trainers took turns presenting lessons, which were accompanied by hands-on practice. While one trainer was presenting a lesson, the other trainers circulated and tutored students at the computers. During practice, the trainer who was instructing circulated and tutored as well.

In the final three weeks, students wrote their own programs (typically games). Students were scheduled in a staggered fashion so that each could work at his/her own computer: students deemed to need the most help were specifically assigned to the first week so there would be an opportunity for them to use the entire three-week period; students with the best performance to that point were scheduled only for the final two weeks. Trainers helped trainees think through and develop their ideas for a program, tutored them on programming logic and techniques, reviewed as necessary, and occasionally taught new commands to individual students if needed for their particular program ideas. Most student games were typically patterned to some extent after commercial games they had experienced.

The course was entirely taught by students. Staff served in an advisory capacity; carried out administrative details; intervened only as necessary (e.g. to direct a trainer's attention to a student needing help, or to rearrange seating if that seemed desirable); and facilitated group planning, implementation, and evaluation.

Evaluation of Pilot Class (I) and Revisions for Summer Classes (I and II). Following completion of Class I, evaluation by staff and trainers called for a

number of changes to be made for the next phase of training scheduled for summer 1983: (1) adding an introductory session on computers and their uses, including software (with hands-on demonstrations and tryouts on a variety of computers), a simple introduction to programming with Big Trak; and demonstration of game programs written by previous students; (2) thus, delaying until the second day the introduction to BASIC; (3) adding one week, or six hours, for additional instruction time; (4) developing handouts to help explain and illustrate lessons and worksheets for structured practice; (5) providing expanded guidelines and options for final programs to allow students to write programs other than games (which trainers felt were difficult for some students); (6) including flowcharting concepts, beginning with simple examples in early lessons and building concepts throughout succeeding lessons; (7) adding students who successfully completed the previous class as tutors; (8) offering credit as an incentive to complete the course (and thus counteract the dropout problem of Class I).

3. Class II

The school district agreed to grant credit for the summer training classes. We recruited students from a second San Francisco inner-city high school through school staff. Since response came primarily from bilingual teachers, the class was composed of all Hispanic students. While some students failed to show for the class, additional students were recruited through those attending. Two students from Class I served as tutors, and a Spanish speaking student was also recruited from the target high school as a tutor. Tutors as well as trainees received credit. The revisions enumerated above were incorporated into the training, and the class met as before but in mornings instead of afternoons: two hours per day three days per week over eight weeks, for a total of 48 class hours.

Description of Students. Ten students (six females, four males) entering the 9th through 11th grades at the target high school in the fall (one female later arranged to attend another city high school) enrolled and all ten completed the course. All were relatively recent immigrants from Mexico and Central America and had been in the U.S. from five months to five years (all but one for three years or less, with a median residency of 1 year, 9 months). Two students (one male, one female) had been here just 5-7 months and spoke no English; the two female students just entering the 9th grade spoke bilingually but were fairly fluent in English (both also had a B higher average GPA from middle school). The remaining students were limited English speaking; all except the two 9th-grade females spoke almost exclusively in Spanish among themselves.

Instruction and Class Schedule. Class II began the end of June and continued for eight weeks until mid-August. The revisions enumerated previously were incorporated into the class format, and lesson presentations and tutoring proceeded as in Class I, with five weeks devoted to the lessons and three to writing final programs. Pairs of students were allowed to work together on final programs if they wished, acknowledging the importance of cooperative learning for Hispanic (and other minority or disadvantaged students) and the observation that the two Hispanic females who dropped out of Class I after they had begun to attempt to write their own individual programs may have remained had they been able to work together. The Spanish-speaking tutor quickly assumed a very important instructional role, especially for the non English-speaking and LES students. He also translated lists of BASIC commands and statements as well as the daily evaluation forms into Spanish, which were very helpful to the students.

4. Class III

In response to staff from the National Office of Samoan Affairs (NOSA), who were conducting a CETA training program for Samoan youth and who had observed

Class II in progress, we initiated a second summer class for 11 students from their program. The NOSA staff felt that computer training would be a good opportunity for their students, who as a group had had very limited contact, if any, with technology; they were concerned that Samoan young people needed to learn about computers to enhance their educational and future life opportunities. These students had no opportunity for computer instruction in their schools due to their need to devote their time to required and remedial classes.

Description of students. Eleven students (six males, five females) started the class and seven (three males, four females) completed it. They ranged in age from 17 to 21, with only three of the seven actually continuing on to high school in the fall. The 21-year old (male) had graduated, but the other three (females) had not completed high school and were enrolled or planning to enroll in adult school or community college to obtain the G.E.D. The four students not completing the course included two (one female, one male) who dropped out for their own or family health reasons and two (both males) who seemed interested only in playing computer games. Nearly all the students came from very large and often extended family situation, many with nonworking parents. Although an extreme example, one male lived with his mother, father, five brothers, six sisters and ten others, including a cousin also in the computer class.

Instruction and Class Schedule. Class instruction and total time were about the same as for Class II, but the schedule was altered to fit into six weeks since the class did not begin until mid-July. Classes still met three days per week, but 2-1/2 hours per day, for a total of 45 hours.

5. A Project Extension: Peer Tutoring Program in a School Setting (a 4th Class)

Following the completion of classes II and III, plans were made to pursue implementing a similar peer training model in the high school which recruited

the Hispanic students for Class II. CREATE staff met with the school's principal and the computer coordinator (and teacher). Since the school already offered numerous classes in BASIC and the teacher expressed a desire to set up a tutoring program with Karel, a project was planned using this graphics-oriented pre-Pascal language with the school's nine new Apple IIe computer systems.

Description of students. Twelve tutor-trainees were ultimately selected, including one of CREATE's tutors and three CREATE summer students (one male and two female Hispanics, and one male Samoan) and eight others (four Black females, one Hispanic male, one Chinese male, one Middle-Eastern male, and one Samoan female). Students ranged from 9th to 12th graders. One Hispanic male dropped out after the second class due to a conflicting sports activity. As of the end of the instruction (training of tutors) phase, the remaining 11 students (including all four of the previous CREATE students) continued in the project, although two Black females exhibited marginal attendance.

Instruction and Class Schedule. The school's computer coordinator began Karel instruction in late November 1983 with classes held twice weekly for two hours after school. The instruction continued for the equivalent of five weeks, when school was in session, through February 1984. Typically, a short lesson to introduce new concepts was taught in a classroom next to the Apple computer lab. Then most of the two-hour class time was spent in the computer lab trying out lesson concepts and accompanying exercises. Following the five weeks' worth of instruction, students were allowed to practice on their own until they felt they had mastered the material and thus felt ready to begin tutoring.

Next stage: Implementation of the Tutoring. Due to delays in the program because of health problems in the teacher's family, the actual tutoring phase has not yet begun. The plan is that once a student can demonstrate to the teacher proficiency in the Apple Pascal operating system, the Karel language, development

of programs, and program structuring for efficiency and ease of reading, he/she will become a paid tutor. Because of the delays, for this paper we will not report evaluation results concerning students learning Karel from tutors or concerning which students make good tutors. These will remain questions for future examination.

III. RESULTS

The data gathered were used to document the project for evaluation purposes only. Our primary purposes for the training project were: 1) to develop a strategy that could serve as a model for programs that could be implemented in schools (or communities) to provide computer instruction to underutilizing students; and 2) to evaluate whether lower-achieving students and other underutilizers could learn programming effectively through our strategy. Therefore, we were interested in evaluating the training in terms of students' cognitive and affective outcomes, social interactions (or social climate), and the students' reactions to the class in general. Since we had small numbers of students involved, our analyses and results cannot be generalized beyond our sample, but they can serve to highlight a variety of equity issues; to suggest some notions about refining and implementing similar programs; and to point to some questions for further study.

A. Student Ethnicity, Sex and Course Completion

Table 1 presents a breakdown of the three classes and total sample by ethnicity and sex according to enrollment in and completion of the course. Class IV was not included in our analyses but occasioned comments about that class will be included.

Over all three classes, there were 33 students (16 males, 17 females) enrolling, with 24 (10 males, 14 females) completing the classes. Thus, nearly three-quarters of the sample finished the course, for slightly over a 25% dropout rate. The highest dropout occurred among males as a total (37%) and among Asian and Samoan males particularly (50% each). Among Hispanics, both males and females had only a 20% dropout rate, although in both Class I and Class II, there were higher enrollment rates for females than males among the Hispanics. In both Class I and Class III, an equal or greater number of males actually enrolled, but in both instances the 50% dropout of males by the end of the class

mean that more females than males completed the entire course. Both Hispanic and Samoan females had among the highest completion rates (80% for both). Less than 20% of females overall dropped out, while nearly twice that percentage of males did.

Among ethnic groups, Hispanics as a whole had the highest success rate (80%) as measured by course completion, 20% or nearly 20% higher than Asians and Samoans, the only other two ethnic groups with multiple numbers in the sample. Completion rates were also higher in the two summer classes offering credit than in Class I, which was held without credit and was in addition to students' classloads at school.

Course completion figures for Class IV, at least through the instruction phase, were consistent with those for the previous three classes. Fifty-eight percent (7 of 12) of the students enrolled and 64% of those completing the instruction (7 of 11) were females. However, teacher and CREATE staff observations indicated that the five students who appeared to be the most ready for tutoring included three males (Hispanic, Chinese, and Middle-Eastern, all 12th graders) and two females (two Black 9th-grade twins). These five also tended to be the most verbal class participants, as well, and therefore it was easier to judge their progress. The two Samoan students and the two Hispanic females were very quiet, but observations indicated that most likely at least the Samoan male and one of the Hispanic females would also probably be nearly ready for tutoring roles.

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Insert Table 1 Here

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B. Descriptive Statistics on Student Measures

Table 2 presents descriptive statistics, including the mean, median, and range for students' prior GPA, Rating of Class, Class Performance, and Class Attendance. Mean and medians were generally similar for all variables within each class, and the median will be discussed here to describe the groups. Classes I and II were very similar on all statistics for all variables, although there were a larger number of lower GPA's in Class II (and a median GPA of C- versus C+ in Class I) and somewhat lower class performance ratings for students as a whole in Class I.

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Insert Table 2 Here

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Compared to Classes I and II, students in Class III had very low GPA's (median of 1.0, or D) and a considerably lower GPA range (except for one 2.8 Samoan school GPA for a male just arrived here, the other available Samoan student GPA's ranged from only 0.0 to 1.0--extremely low grades. In contrast, their class performance ranked considerably higher than the other two classes and their attendance record was among the highest (even though they missed one class en masse, all being members of a tightly knit social group in which they already knew one another well and tended to do everything as a group). Their ratings of the class were comparable, as a group, to class ratings by the other two classes--although the previously mentioned student just arrived from Samoa gave a rather low rating (3.2) compared to other students in his class and the other two classes. All other students gave ratings from about 4 to 5, with medians (and means) well above 4, all highly positive ratings, given a 5-point scale.

The nonparametric Spearman rank order correlation coefficient (rho) was used as a measure of association among variables because of the small sample size--especially for the individual classes--and distributions either skewed or departing too greatly from normality for some variables. These intercorrelations are shown in Table 3 and will be discussed in the following results sections. The correlations will be considered as indicators of trends for the students within the sample only since it would not be appropriate to generalize to other students or to consider statistical significance for the small numbers of students. In general, relationships appeared to be either non-existent or moderate at the most. Because of the exploratory nature of analyses, the direction of relationships or the absence of relationships provide perhaps the most useful information here.

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Insert Table 3 Here

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C. Prior Achievement and Course Results

Overall, there was a negative relationship between students' prior school GPA and ratings of the class (attitude), indicating that those students who were less successful in the regular school setting held the most positive attitudes toward the computer class. This negative relationship held for both Class I and Class III, while there was no relationship between school achievement and attitude toward the class in II. School GPA had no relationship at all with the computer course performance for the total group of 22 students with GPAs available who completed the three classes. There was actually a negative correlation of GPA with course achievement (performance rating by trainers) in the Samoan class (III), which exhibited the lowest GPA and highest performance among

the three classes, and only a moderate positive relationship in the other two classes. GPA likewise had little actual relationship with course attendance, overall, and again showed a negative relationship for the Samoan students, who also had the highest overall attendance rate for the course.

D. Sex Differences and Course Results

Table 4 presents descriptive statistics, including medians and rank-order intercorrelations (rho) for student variables by sex. Compared to males, females had lower school achievement (C vs. a C+ to B- for males) but higher class ratings and higher class performance, even though their attendance was lower. Prior mean GPA's for females and males in Class IV were nearly identical to overall GPA's for the preceding classes (roughly 2.0 for females, 2.6 for males), although medians were slightly higher: thus, the students involved in the school-site extension of the project appear to be similar to the prior students as a group in terms of school achievement.

School GPA had very little relationship to the computer class performance for females (in fact, was just slightly negative), while these measures were only moderately related for males. GPA was only minimally related to female students' attitudes toward the class (which were very positive overall), but had a strong negative correlation for males. Evidently, among the particular students in these classes, males who did well in a regular school setting were not as highly enthusiastic about the peer teaching or the out-of-school setting (although attitudes were still favorable), compared to males not so well attuned to school and consequently perhaps more motivated in a non-school or peer-oriented environment.

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Insert Table 4 Here

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E. Classroom Interaction

Initiating and Responding: Whole Class and Tutor Interactions. Informal observation notes were made by staff when present in classes. The focus of these notes was on interactions of trainees during whole class instruction (initiating questions or responding to questions put to the class) and with tutors during hands-on practice (initiating questions or responding to a tutor). Although informal, such observations, when tallied, provide a general picture of interaction patterns in the teaching/tutoring process.

Table 5 presents general profiles of trainees in the three classes (and by sex within class) on initiating and responding interactions during whole-class instruction and during tutoring episodes in hands-on practice time. Percentages of all interactions of these types are used as data since amounts of observations time varied across classes; however, it was felt that there were enough observations in all classes (available for 9 to 15 class sessions for each class) to provide relatively representative profiles.

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Insert Table 5 Here

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In Class I, trainees predominantly interacted with tutors (over 90%): females almost always responded to tutors, while males (especially two Asians) also initiated a substantial proportion of their interactions with tutors. Although neither males nor females participated much in the whole class format, when they did, the females (who were mainly the two English-speaking Hispanics) again did more responding and males again (almost always the two Asians--both higher school achievers) did more initiating.

In Class II, interactions of both males and females were almost entirely in response to tutors, with a noticeable absence of any responding to whole-class questions or asking questions of tutors. Questions asked in front of the whole class were almost nonexistent. Both sexes in this Hispanic group had nearly indentical patterns. Undoubtedly, their limited English language skills contributed to their quiet, passive participation.

Class III differed from the previous two classes in that interactions by both females and males, but especially by females, were heavily oriented toward asking or answering questions in front of the whole class. While both sexes responded more than they initiated to tutors, this was more characteristic of males, who were all very quiet with the exception of the oldest male (who tended to serve as the groups's spokesperson). This was a very socially-oriented and outgoing group of students who already were a culturally and socially cohesive group. Some of the males were quiet in class, but were still part of the group.

Specific observations concerning trainee interactions with other trainees were not made systematically; however, overall staff impression was that such interactions were as frequent as whole class and tutor interactions in all classes, especially between pairs of students working together at the same computer or at adjacent computers. Such interactions suggest that cooperative learning arrangements could provide supportive and effective environments for computer instruction among minorities and disadvantaged, as the literature suggests (Slavin, 1978, 1980; Aronson et al., 1978).

Seating Arrangements. Seating charts were made for each day of class in order to track social patterns of trainees working alone or in pairs and whether pairs were composed of students of the same-sex or opposite-sex. Students selected their own places with infrequent exceptions.

Table 6 presents data by class and by sex within class. Classes I and II had roughly similar patterns in that both sexes spent most of the time with approximately one or two same-sex computer partners and a smaller proportion of time with opposite-sex computer partners (especially in Class I). In Class II, both females and males spent more time with varied partners of the opposite sex than students in Class I. When the opportunity was available, females in Class I and males in Class II were more likely to work alone. In Class III, in contrast to the other two, students spent very little time with computer partners of their own sex and close to one-half of their time with partners of the opposite sex (and generally the same partner). Although students as a whole in Class III worked alone a considerable amount of the time, females did so more often than males. Working alone occurred more often in Classes I and III, of course, because there were somewhat fewer students, compared to Class II.

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Insert Table 6 Here

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Questionnaire and interview results. Students in all three classes almost unanimously said they were more interested in computers after taking the class and they liked having students as teachers (23 out of 24, or 96% for both responses). The only negative responses to these questions were from the Filipino student in Class I who had just recently arrived here after a stay in the Philippines where she had previously attended high school. We speculate that she was socialized to having only adults as teachers. She was very shy about asking questions of other students. For the most part, on the other hand, the remaining students said they felt "more comfortable" with peers as teachers than they did with adults.

When asked what they liked best in the class, the predominant response focused on games, graphics, sound, color, or animation (18 out of 24, or 75%), with a high number specifically mentioning doing their own games as the highlight. Clearly, the graphics/games feature was a motivating force for learning programming.

When thinking about what was boring, the largest number (8 of 24, one-third) said "nothing" was boring. Seven (29%) said it was boring when they didn't understand: two of these were the non-English speaking students in Class II, who naturally had difficulty following explanations, but three were the top-rated students in Class I. There were thus different reasons for not understanding, but for whatever reason, it is important to minimize such a source of frustation and find ways to help ensure students' understanding. Four students said too much explaining and review were boring to them.

In apparent response to the latter comment, four students (distributed across classes) indicated they would like to spend more time on the computer (practice). However, eight other students wanted more time devoted to explaining lessons. With the remaining students (the majority) saying they liked the balance of instruction and practice time, it appeared that the classes as taught struck a relatively good balance between whole class-oriented instruction and "hands-on" computer time.

More than one half of the students overall indicated that they thought the class should be longer, either in the length of a class session or the number of weeks, or both. One male said "I could sit here all day." Only one student out of 24 thought the course was too long. A number of students did spend more than the alloted class time working on programming activities. Two males in Class I regularly stayed until 6 p.m. or later until they were "kicked out": these students and two others also came to several additional lab sessions when they

could work on their own and class time. In Class III, the group as a whole stayed up to an hour or more after class on a few occasions. These instances indicate high degrees of motivation among the students, especially when considering that these students had little prior experience and, in many cases, little prior interest in computers. Most students also reported that they would probably take another computer class at school.

Students in all three classes uniformly reported that their parents or families were happy they were taking the computer class, felt it was a good opportunity for them, and thought computer programming was important for them to learn. This type of parental support seemed to be just as evident for females as for males and for all ethnic groups represented.

F. Summary and Discussion

As the evaluation results show, the peer training project was successful in meeting its major goals. Students from different minority groups, including females, low-achieving, and LEP students proved to be generally successful learners of programming skills and were extremely positive in their attitudes toward student teachers, the teaching strategy, and computers. They felt comfortable with other students as teachers and felt like the student trainers understood them. They also often expressed the fact that they liked having several teachers so they could get help faster. Most of the students were able to develop their own programs by the end of the course, with the trainers' help, and felt they could write at least simple programs on their own. Several trainees wrote rather clever computer games, which the trainers felt were as good as those written by typical Lowell high-achieving students.

One of the most interesting and intriguing results was the predominance of females in all of our classes, along with the higher dropout rates of males.

These results are contrary to expectations and to the prevailing evidence regarding the involvement of males vs. females with computers.

Perhaps one or more of several factors in the program might have appealed to females for racial/cultural reasons. The smaller, non-school setting and a cooperative-learning/tutoring approach may have provided a social setting in which young women felt comfortable and motivated. The individual help provided by tutors and the noncompetitive atmosphere may have helped reduce any "computer phobia" of females, as well as other typically underutilizing students, and contributed to their learning and feelings of success. Possibly there just happened to be more motivation or more free time on the part of the particular young women who heard about the class. There appeared to be as much parental support for female students as for males.

Most students who dropped out of the class or missed classes, did so for health reasons or time conflicts, such as working. In the Samoan and Hispanic classes a number of times students missed classes because of hospitalizations or health problems either themselves or in their families. Two Samoan students dropped out for such health reasons. In the first class, two of the young men dropped out to work.

Language problems were encountered with many of the Hispanic students. Many such problems were quite successfully dealt with by utilizing a Spanish-speaking tutor. Had we had such a tutor in the first class, the two limited English-speaking females may have learned what they needed to know to be able to write their own programs and continued to the end of the class.

Although perhaps less obvious, Samoan students can also have problems with English as their second language. In this particular group the most notable such problem was in their writing skills. Samoan students as tutors would probably be helpful in dealing with language situations which might cause problems for these students.

The Samoan students were an especially rewarding group to work with. As noted in the results, these students as a whole, particularly the females, had very low grades in school (in fact, all but one of the young women had dropped out of school) but had the best overall performance in the computer class. They proved to be fast, capable, and extremely enthusiastic learners. The advanced high school trainers did not know the students' school backgrounds (as was the case for all classes) but were quite impressed with these students' ability to "catch on."

Two Samoan young women who were school dropouts have since gained employment in banks and work with computers to some extent. Because of cultural or other reasons, these students did not experience success in school. One young woman (who had dropped out of the computer class because of illness) reflected a good many of the Samoan students' attitudes when she reported that she missed most of her classes at school, but she hated to miss the computer class. Even now, seven months after the class ended, these students speak in glowing terms of their experience in the computer class--as a group, they were apparently highly impacted in a positive sense. The Samoan students' strong cultural ties and group-cohesiveness may have facilitated a helpful learning atmosphere, since they participated as an intact group.

The strategy itself, utilizing students as teachers and tutors of other students, was a definite success. The trainers proved to be competent as well as sensitive and patient. The younger, less experienced, and less social tutors, although less self-assured to begin with, seemed to gain some confidence, as well as programming competence, as time went on. All of them were able to provide effective help to at least some of the trainees. The more experienced trainers had no problems working with both males and females, but a young female trainer (only 14) worked with other females almost exclusively--although

she gained confidence after the first class and seemed to maintain status with the older male trainers, even when she was the only female trainer (the other female did not work as a trainer for the summer class due to other commitments).

General evaluation of the course and content by staff and trainers have led us to plan several instructional changes and additions for subsequent classes, especially the use of various software and somewhat less emphasis on BASIC language

An observation by trainers in all classes was the lack of typing or keyboard skills of students. With the availability now of some effective typing tutor software programs, we plan to initiate the course by building keyboard skills with such software (e.g., MasterType for VIC-20 from Broderbund).

Most students were especially motivated by the graphics, color, sound, and animation aspects of programming and really liked making their own games. In future classes, we plan to move from building keyboard skills to LOGO-like graphics programming (e.g., Turtle Graphics by HesWare for the VIC-20) to capitalize on the obvious motivation of graphics for introducing programming concepts and personal control over the computer.

We also plan to have some hands-on introduction to word processing to supplement an explanation and demonstration of this important and widespread computer use. Word processing software such as HesWriter will be an effective package with the VIC-20.

In reviewing the entire experience, we feel that this peer teaching strategy was effective in providing computer access and encouraging computer interest for groups of target students who, for various reasons, had little or no computer experience (and when they did, it tended to be the stereotypical drill and practice in math or reading lab). And, with the VIC-20 systems with cassette recorders rather than disk drives, we were able to provide such access with very inexpensive equipment (compared to many of the systems available). By

capitalizing on available student expertise and using inexpensive computers, the strategy proved to be a cost effective approach which should be able to be relatively easily implemented in schools or community sites.

IV. IMPLICATIONS

A. Instructional Effectiveness for Target Students

Perhaps the most encouraging result of the training model has been the level of success experienced by students who were clearly low achievers. Positive attitudes toward the class and accomplishment of the course final project were gratifying indeces of the benefits of this type of instruction over what these students had experienced in schools.

The goal of fostering a continuing interest in computing appears to have been successfully addressed. Although follow-ups have been difficult to carry out, almost all students who finished the course indicated that they planned to take additional computer classes. Two of the Samoan students and one student from the first class have pursued employment which utilizes computers. Students from at least three families obtained home computers as an immediate result of the course. Of the dropouts from the three classes many did so for reasons other than an inablility to do the coursework or dissatisfaction with the course (e.g., family pressure to get a job, conflict with other after school activities). With the exception of a few students who couldn't get into crowded computer classes, most of the students, especially the Samoans, with their low grades in school, and LES Hispanics would not have been eligible to take computer classes at their schools. The student-teacher approach to programming offered an effective way for providing instruction which otherwise would not have been available to these students.

B. Implementation Issues

Although there is definitely a need for closer study of methods for maximizing the amount of conceptual understanding about programming, programming

tricks and shortcuts, and transfer of BASIC programming ability to more structured languages, the authors feel that the key issues to address in the design of student-led programming classes concern implementation at school sites. Some of these issues are discussed below.

School Staff Involvement and Commitment. At each step--from recruiting students to making logistical and scheduling arrangements for equipment, determining the course content for school credit, etc--teachers and administrators must be responsible for deciding how such a program will operate at their school. Personal experience exemplifies this rule. Following the three Laboratory classes discussed in this paper, Project CREATE began to work with a high school which serves primarily low-income, low achieving minority students. Enjoying the strong support of the principal, the staff discussed establishing the training model with the computer teacher. It was not our intention to impose a prepackaged model on the school; but the extent of the changes made in the program was not anticipated. First, the teacher was convinced that BASIC is not a suitable language for giving students a step-up on possible future work in the computer field. He wanted to work with Pascal. Second, he wanted control over the instruction so that the role of the students would be more that of a tutor than a trainer. Third, he felt that it was essential that these tutors come from within the school rather than from "outside". Since no existing group of students had the necessary experience, the first phase of the program would be designed to train the tutors. One former tutor and three former trainees from the Laboratory classes attending that school were among the twelve students recruited. These students were then taught the Pascal gaming program Karel the Robot which would serve as the first half of the eventual curriculum, which might move to regular Pascal.

While efforts to use the original student trainer model intact in other settings have begun or are planned (including the training of within-school cadres of trainers), the high school implementation example above underscores the need to work directly with the computer teachers in any case to ensure that the program (1) is not perceived as a threat to the teacher(s), (2) has the expertise, commitment, and support of the faculty, and (3) matches the needs of the students. Administrators should also consider whether it would be better to schedule such a course as a regular course offering or as an after school program. One advantage of an after school program is that hardware resources are stretched farther to serve more students. Another advantage is a logistical one in that student trainers, as well as trainees, would not have to accomodate the course within their regular daily class schedules.

Qualifications of Trainers. Unless the school intends to take on the task of spending one training cycle to develop the cadre of trainers "from scratch", student trainers should already have a strong backround in BASIC programming including knowledge of the commands specific to the hardware to be used, debugging, and Peeks and Pokes, if needed for graphics. Tutors need not have such depth, and students who newly complete the course should be able to take this role and improve their skills in the process. Selection should also take into account the student's ability to interact comfortably with others one-on-one and as a lecturer, and to explain concepts or proceedures clearly and patiently, although some of these skills can improve as students gain experience.

Recruiting Trainees. Anticipate a 25% dropout rate and add a waiting list to get replacements during the first two weeks of class. Although recent research indicates that as many as three students can use one computer without suffering a loss in learning rate, we recommend stationing only two students at a station to maximize hands-on experience which we feel is important for

low-acheiving students. Thus the number of students recruited will be determined by hardware availability.

Scheduling Concerns. To minimize dropouts consider students' class load and the scheduling of the course. Friday and Monday after-school classes guarantee lower attendence. Our Tuesday-Wednesday-Thursday schedule seemed to cause minimal attendance problems. Since the course will become more difficult as it progresses, it is important to plan for the course to finish before students must prepare for final exams in their regular classes.

Course Length. While goals will vary among different schools, the curriculum described in the CREATE classes can be effectively taught in 40 to 50 hours of instruction. If additional time is available it would be desirable to add along the way more information about software applications and word processing or to include these applications and spend less time on BASIC, as we are considering doing in future classes.

Anticipate Language Problems. With Hispanic or other LES students, plan to have resources to assist in instruction. We found that a Spanish-speaking tutor who knew BASIC was able to provide invaluable help to such students. Translations of BASIC commands and statements to Spanish were also helpful. In spite of the language problems, with the special tutoring most of these students were able to learn programming if they attended regularly and applied themselves. One non-English speaking student did very well in the class. As mentioned earlier, tutoring or other bilingual assistance to Pacific Islanders (or other ESL students) could aid some students' programming skill development

Cooperative Learning Structures. Research has demonstrated that cooperative interaction in learning activities is effective in improving the academic performance of many ethnic minority students. Consider incorporating cooperative tasks in using the computer. For example, programming exercises or word

processing activities such as story building, or using data base systems for analyzing social science or business problems can be designed so that participation is required from all students (whether in pairs or larger groups). Role playing the steps involved in developing a guess-the-number game can emphasize problem solving and lead students to developing pseudo-code for writing the programs. Students can also work together in developing their game programs by sharing design and program-writing tasks as well as testing and debugging, thereby jointly enhancing their skills and shared pride in their creations.

C. Some Final Thoughts on Processes and Outcomes

It is gratifying to observe students who would not qualify for high school computer classes learning and enjoying computing. Clearly these students were motivated to learn and invested much commitment to finish their final game projects. Until there is more research on the benefits of computing for improving cognitive skills, it will not be possible to claim that the programming experience truly improves these students' educational and employment futures. Nevertheless, programming clearly provides students with the opportunity to develop an awareness of computer capabilities, to conceptualize and design, to test and problem solve, and to receive concrete evidence of their success in learning a skill--opportunities that may not characterize their regular schooling experience.

Whether or not BASIC language should be used for the programming course is an open question. Clearly the simplicity of the language, its wide availability, and its ready application to graphics programs without expense for software are big pluses. Graphics proved to be the strongest motivator for most of our students. Initiating instruction in programming with graphics seems to be an approach worth trying. LOGO or some other turtle graphics would probably enhance students' sense of control over the computer. Even our advanced high school

trainers, as well as several trainees who happened to do some computer exploring with a TI-LOGO system we had, seemed to be captivated with LOGO. For schools with limited resources, the software expense for most versions of LOGO, or Karel or Pascal, as well as the need for disk drives might be prohibitive (however, we have found the VIC-20 Hes Turtle Graphics for $19.95). Even if schools have the hardware available there are still possible reasons for sticking with BASIC for the target student group. For example dealing with a Pascal editor can be extremely frustrating for awhile, and there may not be the immediacy of feedback with some structured programming to test if the program will run. BASIC can, however, be taught in a structured way, and this approach to BASIC seems highly desirable for emphasizing logic and breaking down a problem into logical parts (e.g., see Luehrman & Peckham, 1983).

Computing should be integrated into the curriculum, as much as possible. We believe that, as microprocessor applications become more widespread the equity concerns regarding the potential cognitive and employment benefits of access to programming instruction will become largely replaced by concerns about access to computer applications such as word processing, data base management systems, and spreadsheet analyses. Such uses can be incorported into most subject matter areas and can be effective tools for enhancing problem solving skills. As Steve Jobs has maintained, the goal of more sophisticated software-hardware integration is to make the computer a tool or appliance like a pencil or toaster. Most people using computers will be using them as tools.

We feel that Project CREATE has designed a useful instructional model for motivating "high risk" learners, providing higher-level computer access, and having potential for implementation elsewhere. However, the next step may be to de-emphasize training everyone to program, focusing instead on guaranteeing that low-achieving and minority students be stimulated by active participation

with computer software emphasizing active problem solving rather than passive drill and practice. The concept of basic skills should include the ability to access and manipulate computerized banks, information networks, and microprocesser-based controllers which will be encountered in many workplaces.

This evolving sense of priorities notwithstanding, the concept of student-managed computer programming instruction remains viable as a model for enhancing student access. It addresses the shortage of qualified teachers and facilities in public schools, and capitalizes on proven principles of instructional effectiveness. We conclude that further development of student computer trainers is highly worthwhile for expanding access to instruction to all students.

References

Anderson, R. E., W. Welch, and L. Harris. Inequities in opportunities for computer literacy. The Computing Teacher, April 1984, 10-12.

Arias, B. Computer access for Hispanic students. Executive Summary: Bilingual Microcomputer Literacy Project, Stanford University, Stanford, California, 1984.

Aronson, E., N. Blaney, C. Stephan, J. Sikes, and M. Snapp. The Jigsaw Classroom, Beverly Hills: Sage Publications, 1978.

Assembly Office of Research, Computer literacy and Work Force Needs: Project Reseach Plans. Sacramento, 1982.

Becker, H. School Uses of Microcomputers. Baltimore: Center for Social Organization of Schools, The Johns Hopkins University, Issue No.2, June 1983 (a).

Becker, H. How schools use micro-computers. Classroom Computer Learning, September 1983, 41-44 (b).

Bracey, G. Computers in education, what the research shows. Electronic Learning, November/December 1982, 51-54.

Brookover W. and L. Lezotte. Educational equity: a democratic principle at the crossroads. The Urban Review, 1981, 13 (2).

Campbell, P. Computers in education: a question of access. Paper presented at the Annual Meeting of American Education Research Association, Montreal, Quebec, 1983.

Cardenas, J. High technology and equal educational opportunity-part II. San Antonio: IDRA Newsletter, August 1983.

Castillo, Cathy. How kids score on computers. San Francisco Chronicle, January 10, 1984, 2.

Cohen, P., Kulik, J. and C.L. Kulik. Educational outcomes of tutoring: a meta-analysis of findings. AERJ, 1982, 19, (2), 237-248.

Connell, R. Schools climb aboard computer bandwagon. Los Angeles Times, Sunday, November 27, 1983.

Crist-Whitzel, J. Effective Teaching for Desegregated Settings: a Review and Application of Research. San Francisco: Far West Laboratory, Report #MESE805, 1980.

Dasho, S. and L. Beckum. Microcomputers and educational equity: the promise and peril. Paper presented at the Annual Meeting of the American Education Research Association, Montreal, Quebec, 1983.

Education Daily. States move to review computer software for bias. Monday, January 23, 1984, 1-2.

Education Daily. Student race, not income, influences school computer policies. Monday, October 31, 1983, 1-2.

El News, Survey finds: micro's greatest educational impact is social. Electronic Learning, September 1983, 18-22.

Emmett, A. American education: the dead end of the 80s. Personal Computing, August 1983.

Euchner, C. 'Equal' access to computers in education could become major issue, experts warn. Education Week, March 2, 1983, 1.

Fisher, G. and L. Finkel. Hi-tech high school benefits few, majority suffers. InfoWorld, 17 (2), 17.

Fisher, G. Access to computers. The Computing Teacher, April 1984, 24-27.

Frank, C. Computers: perspectives and prospectives. Resources, New York City Public Schools, Division of Curriculum and Instruction, Winter/Spring, 1983, 7, (2).

Gibbons, J. Informational technology and its impact on American education. The Computing Teacher, January 1983, 18-29.

Good, T. and J. Brophy. Looking in Classrooms. New York: Harper & Row, 1973.

Gulardo, S. Computer education: a model program. Abstract of a paper presented at the Annual Meeting of American Education Research Association, Montreal, Quebec, April 1983.

Hamilton, M. Are girls smarter than boys? San Francisco Examiner, Sunday, February 12, 1984, Scene Arts, 1-2.

Hechinger, F. Experts warn schools on computer choices. San Mateo The Times, October 15, 1983, I-12

Hess, R. and I. Miura. Sex and class affect summer-camp enrollment. In Focus, April 25, 1983, 52-55.

Karoff, P. Rich school, poor school. Teaching, Learning, Computing, January 1984, 50-56.

Kiesler, S., L. Sproull, and J. Eccles. Do little girls get equal opportunity in the compute world? Psychology Today, March 1983, 40-48.

Kulik, J., R. Bangert, and G. W. Williams. Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 1983, 75, 19-26.

Lesgold, A. and F. Reif. Computers in Education. Realizing the Potential. Chairmen's Report of a Research Conference, Pittsburgh, Pennsylvania, November 20-24, 1982. U.S. Department of Education, Office of Educational Research and Improvement, June 1983.

Luehrmann, A. and H. Peckham. Computer Literacy: A Hands-On Approach. New York: McGraw-Hill Book Company, 1983.

Mace, S. Governor calls for incentives for technical teachers. InfoWorld, 1983, 5, (17), 16.

Marrapodi, M. Boys and girls: equal access? Resources, New York City Public Schools, Division of Curriculum and Instruction, Winter/Spring, 1983, 7, (2).

National Commission on Excellence in Education. A Nation at Risk: The Imperative for Educational Reform. Washington, D.C.: U. S. Department of Education, 1983.

NSBA. The biggest issue in computer education: computer equity. ComputerWise, September 1983, 4-5.

Norman, C. A Teacher Survey NEA Report: Computers in the Classroom. National Education Association, 1983.

Podemski, R., S. Husk, and A. Jones. Micros and the disadvantaged. Electronic Learning, March 1983, 20-22.

Puetz, W. Social implications of pushing for computer literacy. InfoWorld, January 1984, 41-45.

Resnick, H. Creative teachers make computers part of the job. Learning, March 1984, 32-38.

Ryba, K. and J. Chapman. Toward improving learning strategies and personal adjustment with computers. The Computing Teacher, August 1983, 48-53.

Saracho, O. The effects of a computer-assisted instruction program on basic skills achievement and attitudes toward instruction of Spanish-speaking migrant children. AERJ, 1982, 19 (2), 201-219.

Siegel, L. Researchers challenge portrait of a high-tech future. InfoWorld, 5 (20), 31.

Slavin, R. Student teams and comparison among equals: effects on academic performance and student attitudes. Journal of Educational Psychology, 1978, 70, 532-538.

Stevens, G. Computer tutors. San Francisco Examiner and Chronicle, Sunday, September 19, 1982.

TERC, 1983, 6 (1), 2-6.

The Stanford Educator, School of Education News, Winter 1984.

Time, May 3, 1982, 50-56.

Van Nuys, U. Why is the world of computers dominated by males? InfoWorld, 5 (35), 8-10.

TABLE 1

Description of Sample by Class, Race/Ethnicity, and Sex, Showing Number Starting and Completing Each Class

Race/ Ethnicity	Class I Start	Class I End	Class II Start	Class II End	Class III Start	Class III End	Total Start	Total End	% Success Rate
Hispanic									
Male	1	-	4	4			5	4	80
Female	4	2[1]	6	6			10	8	80
Asian									
Male	4	2					4	2	50
Female	1	1					1	1	100
Black									
Male									
Female	1	1					1	1	100
White									
Male	1	1					1	1	100
Female									
Samoan									
Male					6	3	6	3	50
Female					5	4	5	4	80
Totals									
Male	6	3	4	4	6	3	16	10	63
Female	6	4	6	6	5	4	17	14	82
Both	12	7	10	10	11	7	33	24	73

[1] Two Hispanic females completed entire instruction phase of course, but dropped out after the second day students worked on own programs.

TABLE 2

Descriptive Statistics for Three Classes and Total
(Students Completing the Classes)

Class	GPA[1]	Rating of Class	Class Performance	% of Classes Attended
I (n=7)				
$\bar{X}$	2.6	4.4	7.2	83
Median	2.7	4.3	7.6	86
Range	1.2-3.5	3.9-5.0	3.5-9.1	60-100
II (n=10)				
$\bar{X}$	2.5	4.5	7.5	81
Median	2.2	4.6	7.9	81
Range	1.7-3.8	4.0-5.0	4.8-9.5	61-100
III (n=7)				
$\bar{X}$	1.1	4.4	8.8	86
Median	1.0	4.5	9.0	86
Range	0.0-2.8[2]	3.2-4.8	7.7-9.3	79-93
Total (N=24)[3]				
$\bar{X}$	2.2	4.5	7.8	83
Median	2.3	4.5	8.2	83
Range	0.0-3.8	3.2-5.0	3.5-9.5	60-100

[1] On a 4-point scale.

[2] 2.8 was the Samoan school GPA for male student just arrived from Samoa. Without his GPA, range was 0.0 to 1.0, n=5 as two students' grades not available.

[3] Total N=22 and Class III n=5 for GPA for reason mentioned in footnote 2.

TABLE 3

Intercorrelations (Rho's) Among GPA, Ratings of Class, Class Performance, and Class Attendance for Three Classes and Total (N=24)[1]

	Rating of Class	Class Performance	Class Attendance
GPA			
Total (N=22)[1]	-23	-01	33
I (n=7)	-80	36	39
II (n=10)	09	48	44
III (n=5)[1]	-30	-40	-13
Rating of Class			
Total (N=24)		-01	-33
I (n=7)		-07	-37
II (n=10)		02	01
III (n=7)		39	14
Class Performance			
Total (N=24)			34
I (n=7)			04
II (n=10)			62
III (n=7)			-29

[1] Total N=22 and Class III n=5 for GPA (see footnote 2, Table 2).

TABLE 4

Descriptive Statistics (Including Medians and Rank-Order Intercorrelations) For Student Measures by Sex (N=24)

	Median	Range	Intercorrelations (Rho) Rating of Class	Class Performance	Class Attendance
GPA					
Female (n=14)	2.0	0.0-3.8	.20	-.05	.12
Male (n=8)[1]	2.6	1.7-3.5	-.80	.51	.48
Rating of Class					
Female (n=14)	4.6	4.0-5.0		.12	-.09
Male (n=10)	4.4	3.2-4.7		-.09	.22
Class Performance					
Female (n=14)	8.5	3.5-9.5			.36
Male (n=10)	8.2	7.1-9.1			.62
% Class Attendance					
Female (n=14)	.79	.60-.96			
Male (n=10)	.91	.65-1.00			

[1] GPA's were not available for two Samoan males in Class III.

TABLE 5

Class Profiles of Student Initiating and Responding Interactions, During Whole Group Instruction and Individual Tutoring, Given As Percentages of All Interactions in These Categories

Class	Whole Class Interactions		Interactions With Tutors	
	Initiating (%)	Responding (%)	Initiating (%)	Responding (%)
I				
Female (n=6)	1.3	6.4	7.7	84.6
Male (n=5)	8.5	2.8	26.8	62.0
All (n=11)[1]	4.7	4.7	16.8	73.8
II				
Female (n=6)	3.7	0.0	0.0	96.3
Male (n=4)	4.0	0.0	0.0	96.0
All (n=10)	3.8	0.0	0.0	96.0
III				
Female (n=5)	28.9	42.1	7.9	21.1
Male (n=5)	22.2	25.9	7.4	44.4
All (n=10)[1]	26.2	35.4	7.7	30.8

[1] Interactions tallied for all students completing more than one week of classes.

TABLE 6

Student Seating Arrangements: Percent of Time Spent With Same-Sex and Opposite-Sex Computer Partners and Time Spent Alone

Class	Same-Sex Computer Partners			Opposite-Sex Computer Partners			Alone
	% Time	Ave. No.	% of All Partners	% Time	Ave. No.	% of All Partners	% Time
I							
Female (n=6)[1]	57	1.3	67	10	0.7	33	33
Male (n=3)	69	1.7	71	12	0.7	29	19
All (n=9)[1]	61	1.4	68	11	0.7	32	28
II							
Female (n=6)	62	2.3	61	25	1.5	39	13
Male (n=4)	52	1.8	50	18	1.8	50	30
All (n=10)	58	2.1	57	23	1.6	43	19
III							
Female (n=4)	09	0.8	38	47	1.3	63	44
Male (n=3)	15	1.3	50	50	1.3	50	35
All (n=7)	12	1.0	44	48	1.3	56	40

[1] Includes two Hispanic females who completed most of course but dropped out after 5 weeks.